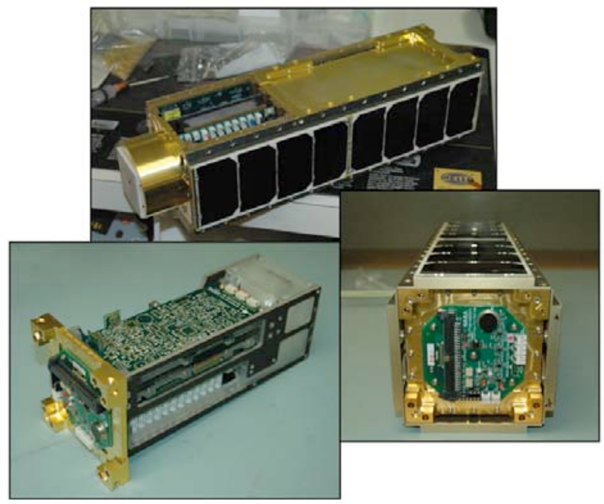
PharmaSat Flight Project

As a follow on to the highly successful GeneSat-1 Mission, the Ames Small Spacecraft Division is collaborating with industry and local universities to develop the next generation fully-automated, miniaturized triple cubesat spaceflight system for biological payloads. The PharmaSat experiment and flight system will be designed to measure the influence of microgravity upon yeast resistance to an antifungal agent. PharmaSat implements PI guided science focused on questions key to countermeasure development for long-term space travel and habitation.

Background

PharmaSat will build upon the extensive technology development program and recent flight heritage of GeneSat-1. GeneSat-1 combined innovative miniaturization and integration strategies with recent developments in microfluidics and optics in a robust free-flying satellite, self-powered and weighing under 5 kg, that provided life-support, growth, monitoring, and analysis capabilities for microorganisms. Retrofitting GeneSat-1 to save significant cost and schedule, PharmaSat will accomplish five critical functions in an autonomous free-flyer platform:

- Provide life support and environmental control for growth of the yeast strain in 48 independent microwells
- Dose the growing yeast with antifungal agent at the appropriate point on the growth curve with three distinct, well-defined dosage levels, plus a zero-dose control
- Track the population of the yeast via optical density of each microwell before, during and after antifungal administration
- Determine well-by-well yeast viability at multiple, well-defined times after antifungal administration using a colorimetric reagent, Alamar Blue
- Telemeter the resulting population and viability data to Earth, along with system status data.



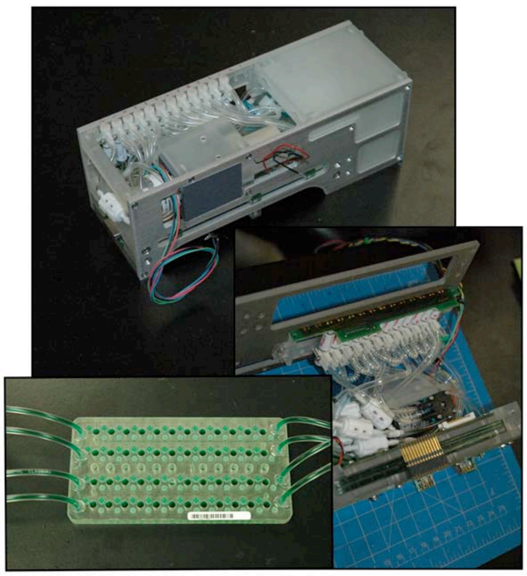
PharmaSat Flight Article

Technology Overview

The PharmaSat Team at Ames Research Center is designing and developing miniature biological stasis, growth, and analysis systems along with the necessary life support and culturing capabilities to study model small/micro organisms in nanosatellites. The PharmaSat system is fully self-contained and autonomous, and transmits results to Earth, requiring no specimen return. The main technology subsystems include a 3-color optical absorbance system, microfluidic networks, multiple reagent delivery system, and miniature environmental control and power management systems.

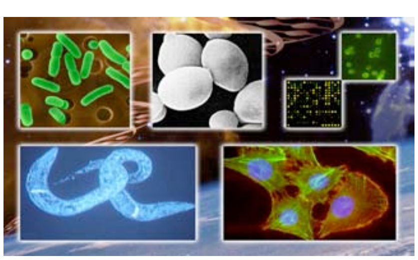
PharmaSat

Retrofitting the existing GeneSat-1 platform offers the opportunity to conduct research in microgravity without the need for resources available on Station or during Shuttle flights. This opens numerous secondary payload opportunities to conduct biological research in space at lower cost and with greater frequency than possible before



PharmaSat Payload Fluidic System

The PharmaSat fluidic system will enhance and augment the methods and configuration developed for GeneSat-1. The number of fluidics microwells will increase from 12 to 48 to provide more statistically significant *n*'s, wells will be addressed independently in 4 groups of 12 to enable multiple antifungal concentrations to be studied, and as many as 3 different reagenst will be independently added. A dozen additional well will be provided for solid-state optical control/calibration samples.



Relevance to Exploration Systems

For safe, long-duration space missions, the debilitating effects of the environment such as bone density loss, muscle atrophy, and a stressed immune system must be addressed. In terrestrial medicine, powerful recent advances in therapeutics have come from detailed understanding of biological mechanisms and pathways at the molecular level. The miniaturization of the tools, methods, and liquid volumes of modern molecular biology, as well as the sensors, electronics, and processors necessary to implement sophisticated analytical measurement systems, is enabling autonomous systems that are particularly suitable to growing and analyzing microorganisms under challenging constraints of size and power. The GeneSat-1 platform and derivatives such as PharmaSat are ideal for executing a broad spectrum of research approaches to understand space-environment related effects in microorganisms. It is a particularly suitable family of platforms to evaluate potential countermeasure development.

The use of low-cost, small-size, autonomous secondary payload concepts provides a means to study biological changes of fundamentally well-understood microorganisms and mammalian cells at the gene/protein level. Such knowledge will be key to the development of effective countermeasures to the deleterious effects of long-duration space travel.

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